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From Ambient to Personal Temperature: Capturing the Experience of Heat Exposure

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Heat exposure can have a wide range of adverse effects on the human body.[1] But when researchers set out to measure the precise size of those effects across populations, they typically are forced to rely on imprecise exposure data. The authors of a new commentary in *EHP* outline an alternative approach to better assess how individuals experience heat.[2]

Most studies on heat health rely on ambient temperature readings from airports and other fixed weather stations. These data cannot capture social and behavioral factors that influence heat exposure on a finer scale, nor do they reflect temperatures indoors, where many of us spend our time. Thus, they do not reflect what most individuals experience in their daily lives.[2]

In contrast, so-called personal heat exposure research uses wearable sensors and advanced modeling to capture data at the individual level. "We're trying to measure what an 80- or 90-degree day means in terms of what people actually experience," explains senior author David Hondula, an assistant professor in the School of Geographical Sciences and Urban Planning at Arizona State University.

"One of the values of this kind of data is it allows us to make what is otherwise invisible visible," says co-lead author Evan Kuras, a graduate student at the University of Massachusetts Amherst. By studying heat exposure at the individual level, he says, "We may discover things that we might not have thought to pay attention to."

Only a few studies have used personal heat monitoring in the general population, as opposed to groups at high risk for heat stress, such as athletes, outdoor workers, and members of the military. In one example, commentary coauthor Molly (Bernhard) Richardson, a postdoctoral fellow in population health sciences at Virginia Tech, measured temperatures experienced by 81 individuals in rural and urban Alabama over the course of a week in the summer of 2012.[3] In another, Hondula and Kuras measured temperatures experienced by 23 Boston residents over a week in July 2013.[4]

For the duration of these studies, participants wore temperature monitors whenever possible, indoors and out. For the Boston study, dime-size iButton sensors were clipped to belt buckles or bags, while for the Alabama study, slightly larger HOBO Pendant sensors were clipped to subjects' shoes.

These studies, although small in scale, nonetheless produced noteworthy findings. Kuras and Hondula's study found significant differences among the temperatures experienced by the participants, even though they all lived within the same urban neighborhood. Generally, however, the participants' personal heat exposures were lower than the outdoor ambient temperature.

Richardson's study concluded that qualities of the participants' home environment—including everything from location and quality of construction to presence of fans and air-conditioning—

The authors of a new commentary point out that everyone has a different experience of and response to heat. Data on personal heat exposure are important for designing effective strategies to help whole populations cope with heat waves. Image © Andy Parker/iStockphoto.

played an important role in determining their overall heat exposure.

Both studies were designed primarily as pilots for future research. This summer, Richardson will lead a follow-up in Alabama with a new sensor and more than twice as many participants.[5] Other ongoing work is being led by climatologist Chris Fuhrmann of Mississippi State University. Over the past year, Fuhrmann has used the iButton sensor to study temperatures experienced in football stadiums by spectators and athletes, and on university campuses among groundskeepers.[6] This summer, he will measure heat in mature cornfields.

Fuhrmann and Australian National University associate professor Kathryn Glass note that such precise ground-level data can serve additional roles by validating satellite-based thermal imagery and improving algorithms and models for research and public policy alike.

"You need to know about individual-level factors across lots of individual people to know what is happening to the population," says Glass, who specializes in epidemiological modeling. With heat exposure, "you are often having to make assumptions, [for instance] about what it is likely to be like inside a building. Having some actual data is very helpful."

Nate Seltenrich covers science and the environment from Petaluma, California. His work has appeared in *High Country News*, *Sierra*, *Yale Environment 360*, *Earth Island Journal*, and other regional and national publications.

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